NOAA's National Weather Service

Basic Concepts of

Severe Storm Spotting

2009 – Rusty Kapela

Milwaukee/Sullivan

weather.gov/milwaukee

Housekeeping Duties

- How many new spotters? - if this is your first spotter class & you intend to be a spotter – please raise your hands.
- A basic spotter class slide set & an advanced spotter slide set can be found on the Storm Spotter Page on the Milwaukee/Sullivan web site (handout).
- Utilize search engines and You Tube to find storm videos and other material.

Class Agenda

- 1) Why we are here
- 2) National Weather Service Structure & Role
- 3) Role of Spotters
- 4) Types of reports needed from spotters
- 5) Thunderstorm structure
- 6) Shelf clouds & rotating wall clouds
- 7) You earn your “Learner’s Permit”

Thunderstorm Structure

Those two cloud features you were wondering about…

Storm Movement

Shelf Cloud	Rotating Wall Cloud
Rain, Hail, Downburst winds	Tornadoes & Funnel Clouds

Fake Tornado

It’s not rotating & no damage!

Let's Get Started!

Video

Why are we here?

Parsons Manufacturing 120-140 employees inside

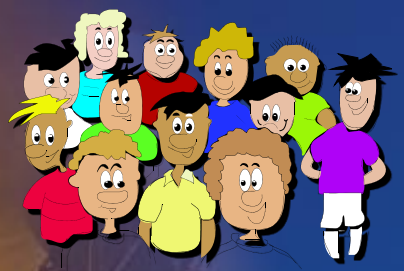
July 13, 2004
Roanoke, IL

F4 Tornado – no injuries or deaths. They have trained spotters with 2-way radios

Why Are We Here?

National Weather Service's role

- *Issue warnings & provide training*



Spotter's role

- *Provide ground-truth reports and observations*

We need (more) spotters!!

National Weather Service Structure & Role

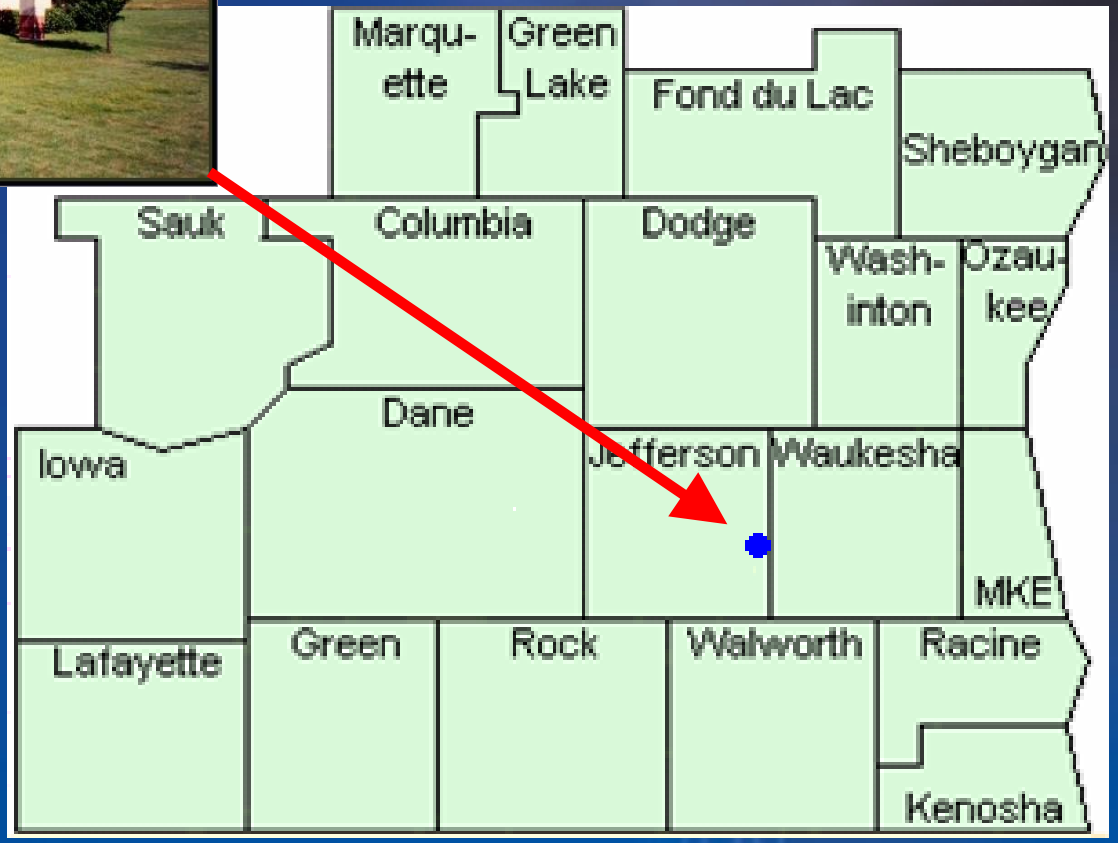
- Federal Government
- Department of Commerce
- National Oceanic & Atmospheric Administration
- National Weather Service

122 Field Offices, 6 Regional, 13 River Forecast Centers, Headquarters, other specialty centers

Mission – issue forecasts and warnings to minimize the loss of life & property

National Weather Service Forecast Office - Milwaukee/Sullivan

Watch/Warning responsibility for 20 counties in southeast and south-central Wisconsin.



What Do You See?

Video

Oakfield, WI - July 18, 1996

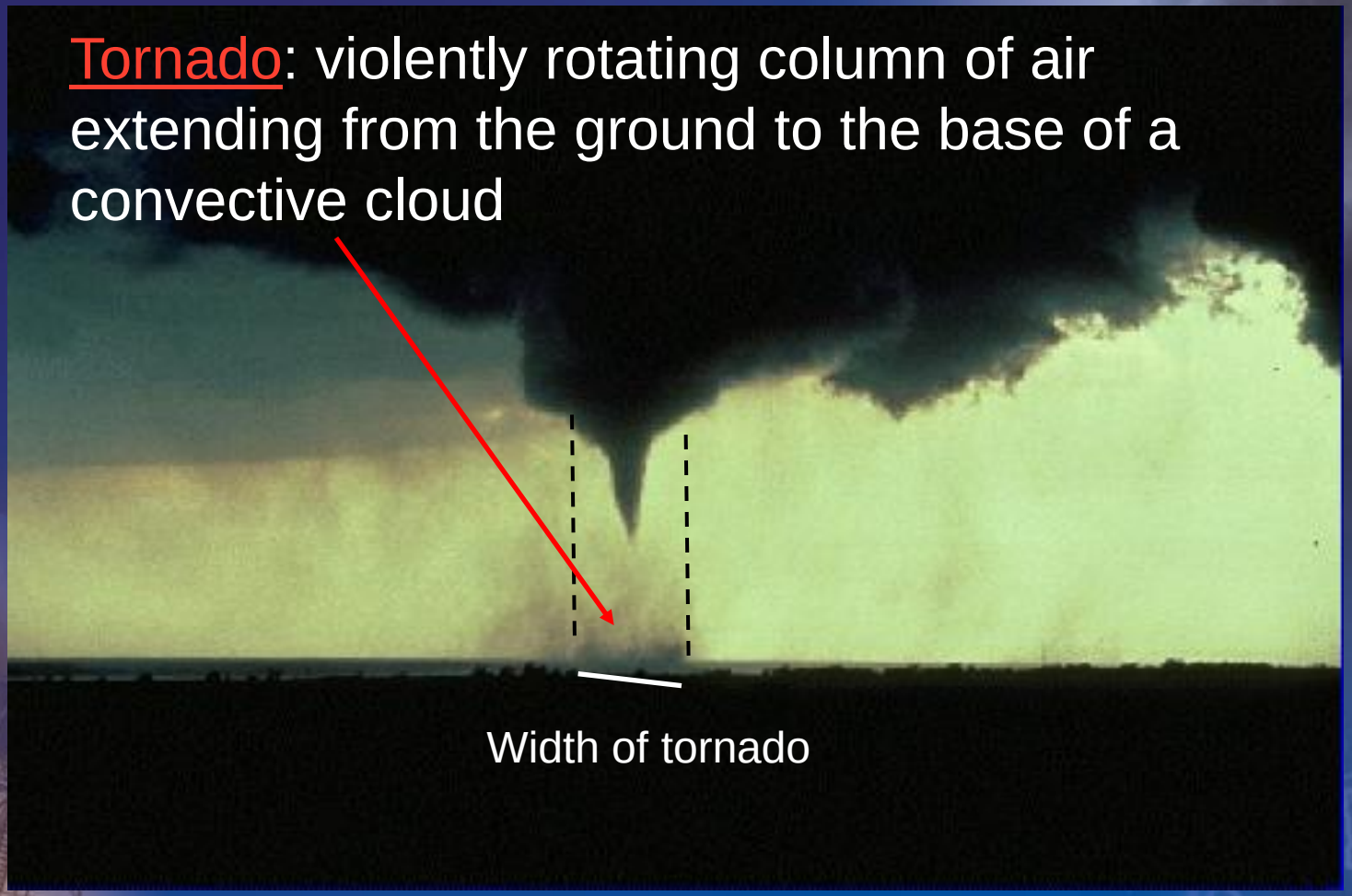
- *Reached F5 intensity*
- *30 minute duration*
- *Maximum path width of 400 yards*
- *13.3 mile path length*
- *$40.5 million in damages*
- *12 injuries*

(705-735 pm… people could see it, county fair in progress, and Oakfield police officers and fire fighters recognized early on when they had a tornado and activated their sirens)

Lessons Learned
- from Oakfield Tornado

- Tornado can develop before so-called funnel cloud
- So-called funnel cloud isn't the tornado and it sits inside the invisible tornado
- Sometimes you can't tell you have a tornado until you see rotating dirt/debris at ground level with cloud-based rotation directly above
- Tornadoes don't touch down – they spin up below cloud base - but many condensation funnels (what most people call a funnel cloud) do develop down to the ground – "touch down"

Tornado



Note swirling debris at ground level. Condensation funnel doesn't have to "touch" ground…condensation funnel isn't the tornado. Once you have a tornado, you don't have a funnel cloud.

The Effective Spotter Report

TV

800#

Hams

911

What do You Report?

Flash Floods

Straight-line Winds

- Tornadoes
- Funnel Clouds
- Rotating Wall Clouds

Hail

What do You Report?

Damaging Lightning

- Lightning is your most dangerous hazard as a spotter.
- Normally, lightning reports are not needed during the heat of the battle
- If you are aware of a lightning-related fire or deaths or injuries, send info via E-spotter

What do you Report?

- **Tornadoes,** funnel clouds (nothing going on at the ground, and rotating wall clouds
- **Hail stones** ½ inch in diameter or larger. Hail stones => 1 inch generate Severe Thunderstorm Warnings
- **Thunderstorm wind gusts** 50 mph or higher. Gusts =>58 mph generate Severe Thunderstorm Warnings
- **Flooding** – water over the curb or covering a road, rainfall amounts => 1 inch

General Report Format - TLCS

* Time event occurred?

  - To the nearest minute

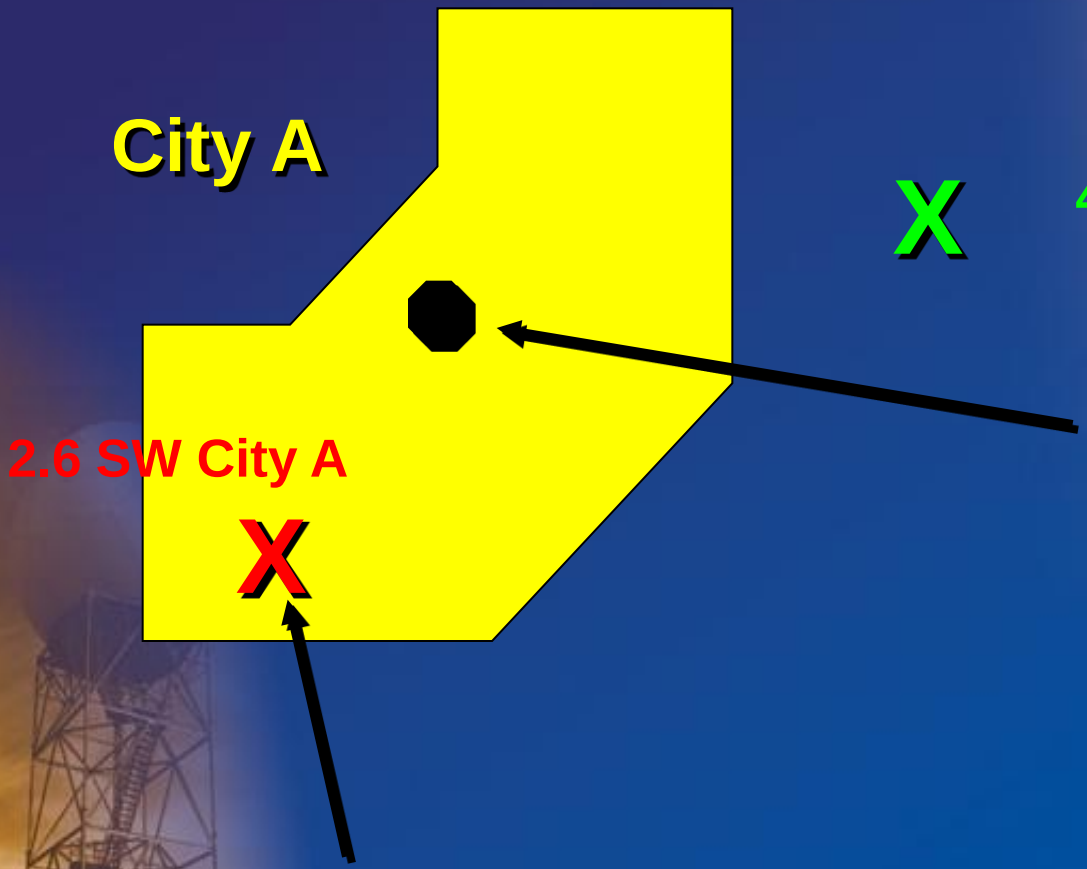
* Location of spotter (stationary spotter) referenced to the nearest city/village?

  - To the nearest 1/10 mile (as the crow flies) and one of 16 compass directions

* Condition – what are you looking at or experiencing – what is the event?

* Source – some identification, ID letters, agency, etc.

Reference Location



Note – in addition, we will take lat/long numbers

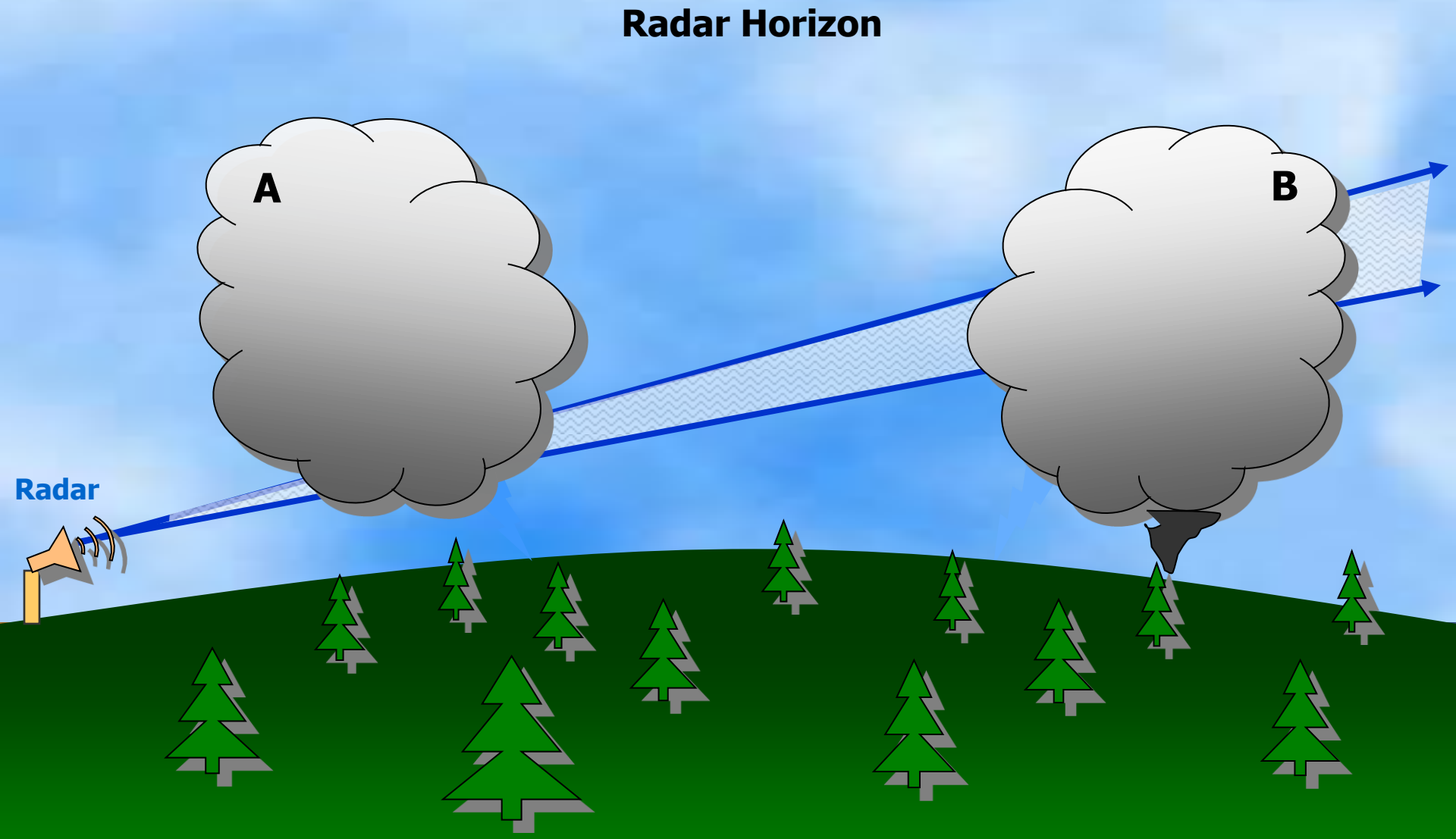
General 911 Report Format

- “Hello, I’m a trained severe weather spotter. At 4:05 pm, at a location 1.1 miles north of Saukville in Ozaukee County, I observed estimated golf-ball sized hail.” My name is…
- “Hello, I’m a trained severe weather spotter. It’s 6:30 pm. I’m located in Brownsville in Dodge County. I observed a tornado to the north of me in Fond du Lac County. Dispatcher tells NWS tornado is in Fond du Lac County, north of Brownsville.
- “Hello, I’m a trained severe weather spotter. It’s 630 pm. I’m located in Brownsville in Dodge County. I observed a tornado. Dispatcher tells NWS that tornado is in Brownsville.

General 911 Report Format

- Always mention if the size, speed, in your report is either estimated, or physically measured.
- Try to reference your location to a city/village that is in your county (spotter location)…do not use a city/village in another county unless it is on the county line.

Why we Need Spotter Reports



Radar beam cannot see lower portion of storm "B"

On-line Report System

Register on our Storm Spotter Page

NOAA Weather Radio All Hazards

Your own personal siren - your home has a smoke alarm – does it have a weather radio?

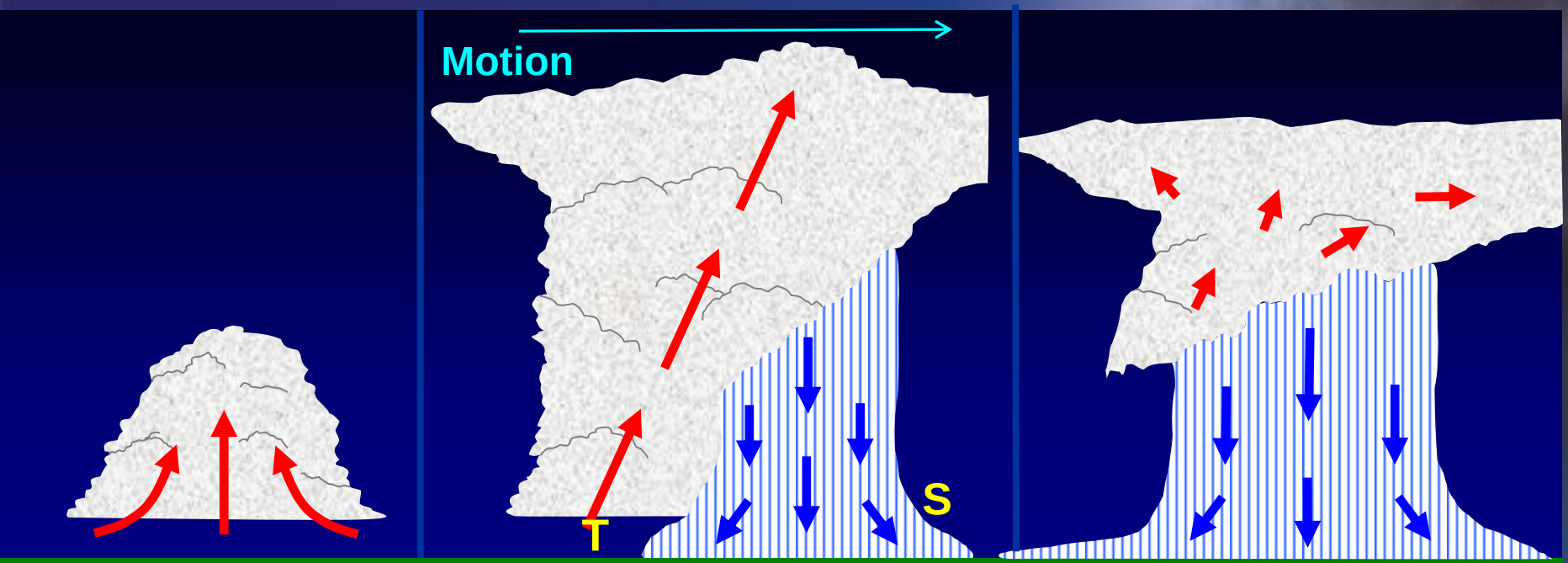
- Receive weather information 24 hours a day
- Radio will sound a tone to alert you when a watch/warning has been issued
- Countless times, lives have been saved by NOAA Weather Radio

NOAA Weather Radio

Thunderstorm Structure

- Think of a thunderstorm as a 2-part engine
- Updraft tower – intake manifold (inflow) – inhaling warm, moist air – air goes up at 60 – 120 mph, the warm moist air is the gasoline supply. Rotating wall clouds, tornadoes (T), & funnel clouds underneath updraft tower. (rain-free base)
- Downdraft tower – exhaust manifold (outflow) – exhaling of rain, hail, rain-cooled air, and gusty downburst winds that in extreme cases reach speeds of 60 to 150 mph! Shelf cloud (S) precedes.

Thunderstorm Life Cycle



Cumulus Stage | Mature Stage (Cell) | Dissipation Stage

Thunderstorm Structure

Those two cloud features you were wondering about…

Storm Movement

Shelf Cloud	Rotating Wall Cloud
Rain, Hail, Downburst winds	Tornadoes & Funnel Clouds

Shelf Clouds vs. Wall Clouds

Shelf Clouds

Suggest downdraft/outflow

Move away from precipitation areas

Horizontally orientated and can extend for miles. Rare…but may "roll" like a rolling pin.

Wall Clouds

Suggest updraft/inflow

Maintain position with respect to precipitation

Isolated, vertically orientated, ***and rotating,*** *like a spinning skater*

Shelf Clouds vs. Wall Clouds

Shelf Clouds

Appear on front side of thunderstorm cells just ahead of the downdraft.

Can extend for 10 to 50+ miles and have cloud fragments that **briefly resemble funnel clouds**

Often resemble a “snow plow” since the colder air with the downdraft undercuts warmer air found out ahead of the storm.

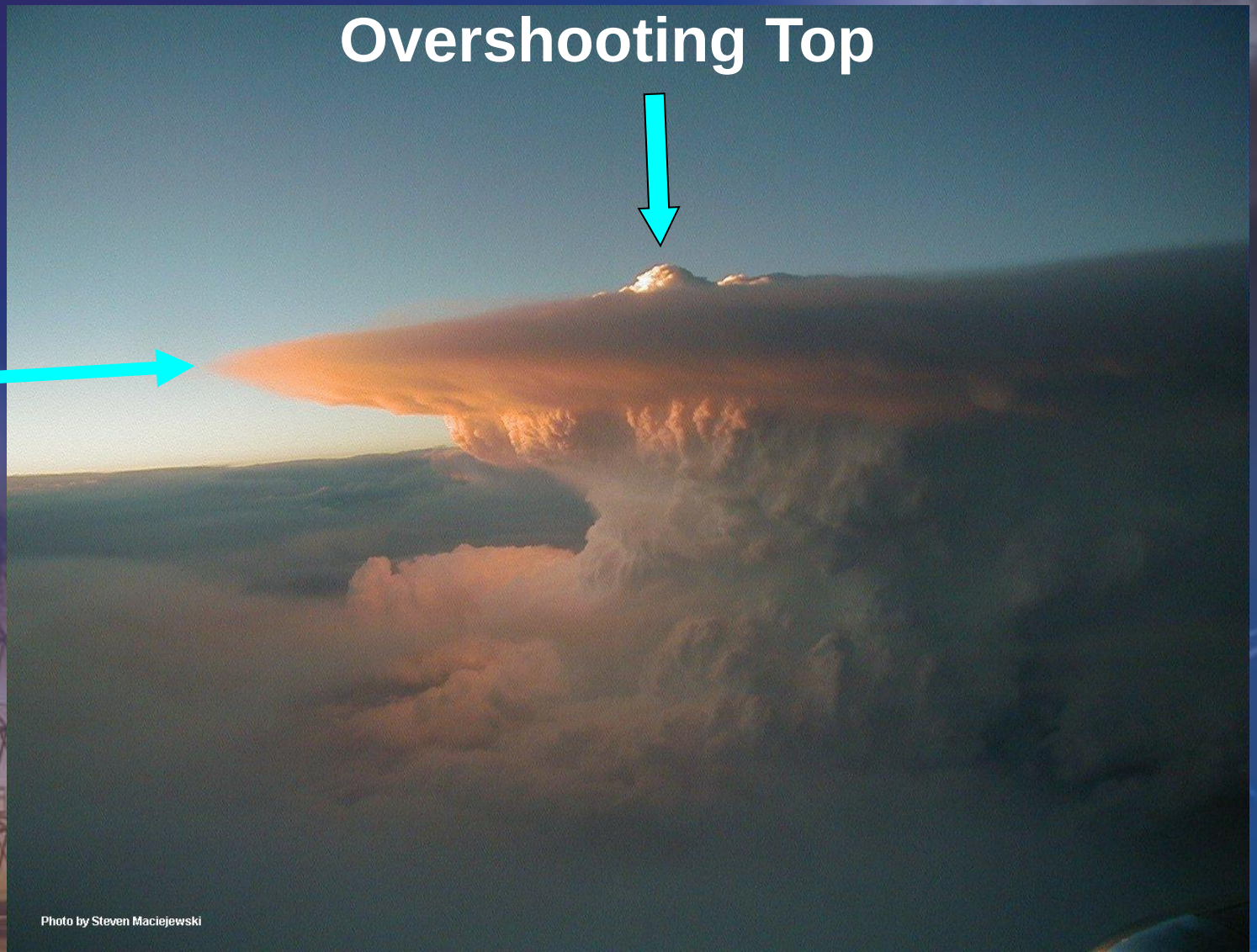
Wall Clouds

Appear on the backside of a potentially tornadic thunderstorm.

Will change their shape, size, and color with time. Width typically ½ mile to 2 miles.

The can be fragmented or look like a beer barrel

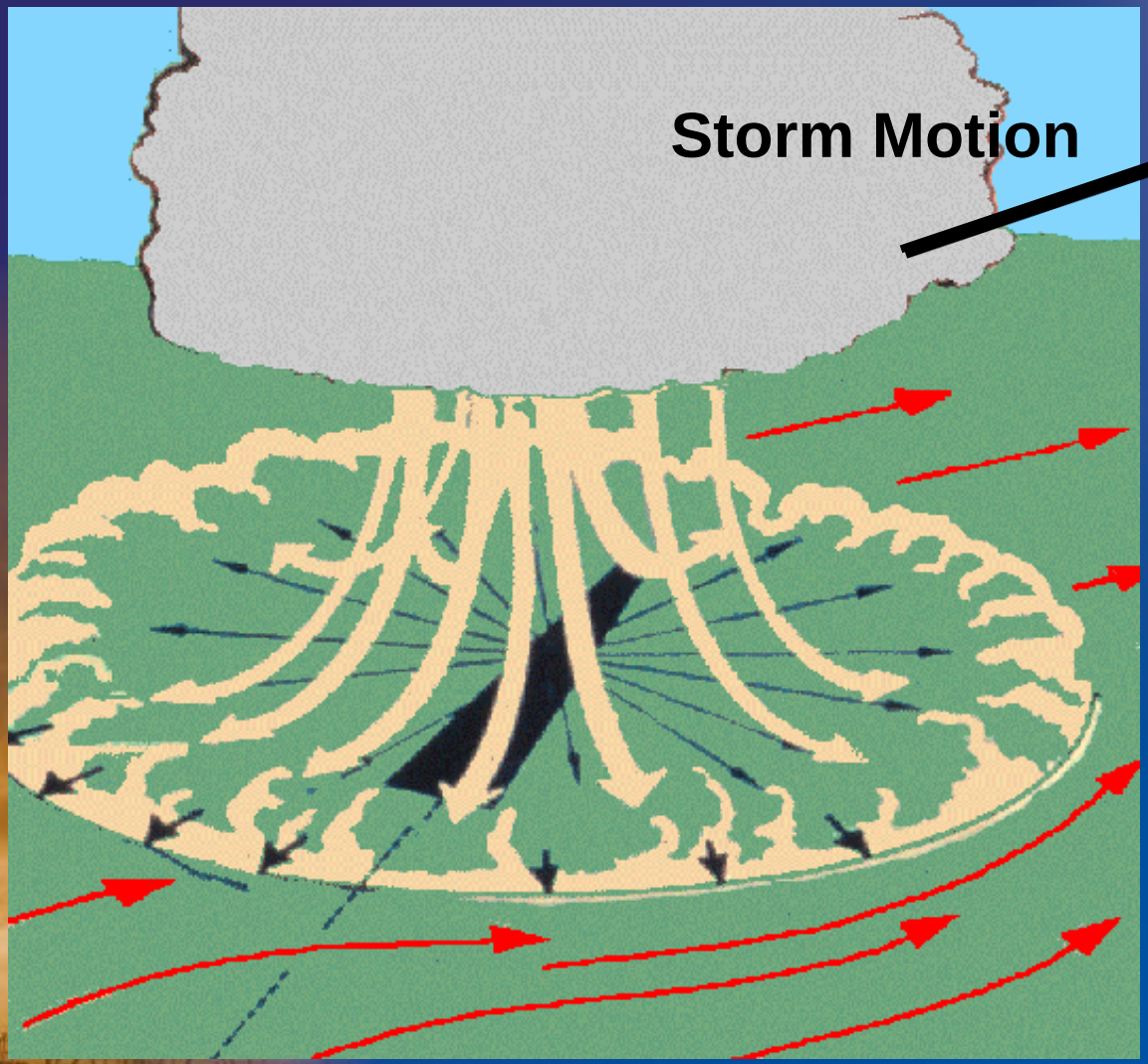
Thunderstorm Structure



Thunderstorm Structure

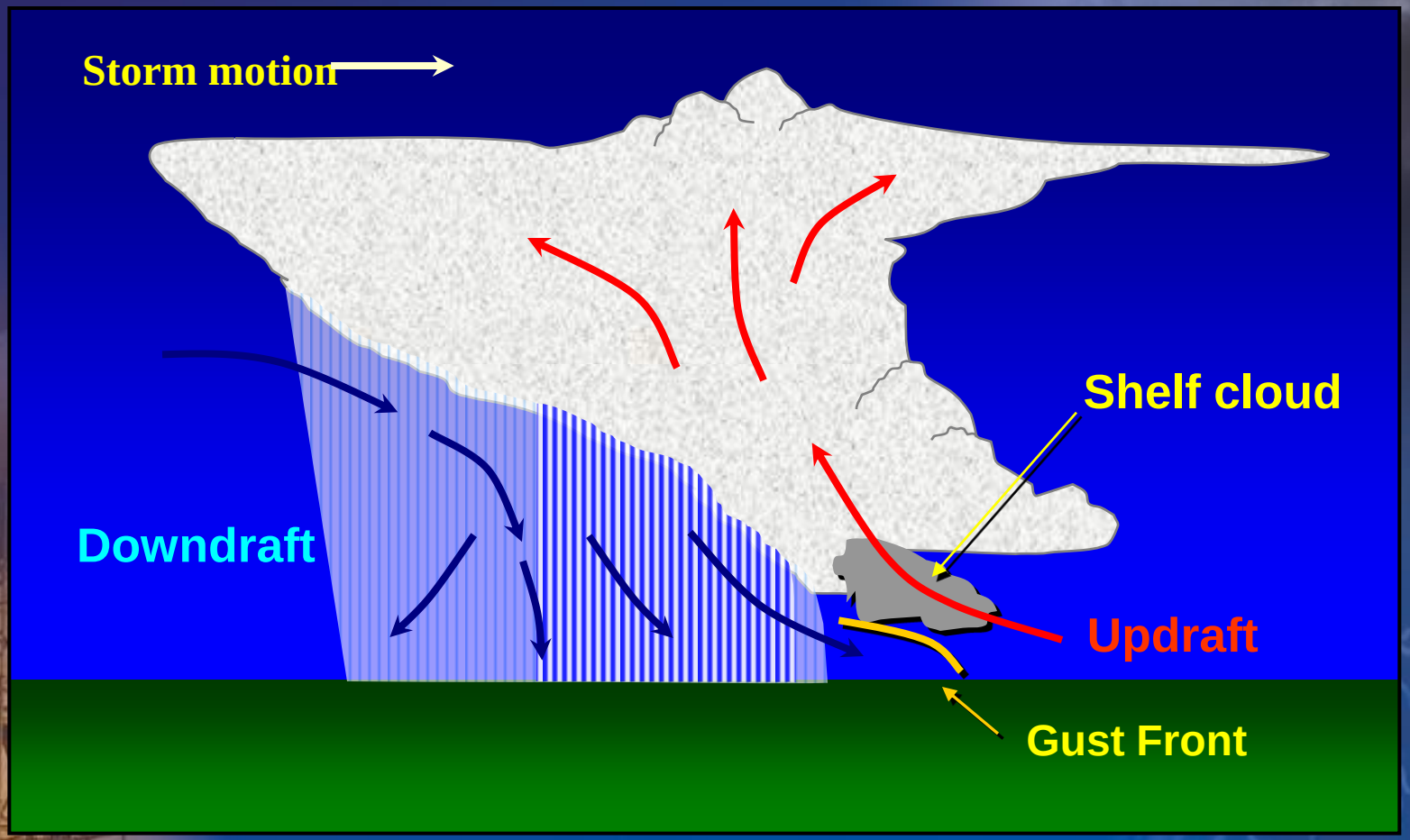
Mammatus Clouds – these are not funnel clouds they are found on the underside of the anvil

Downdraft - Downburst



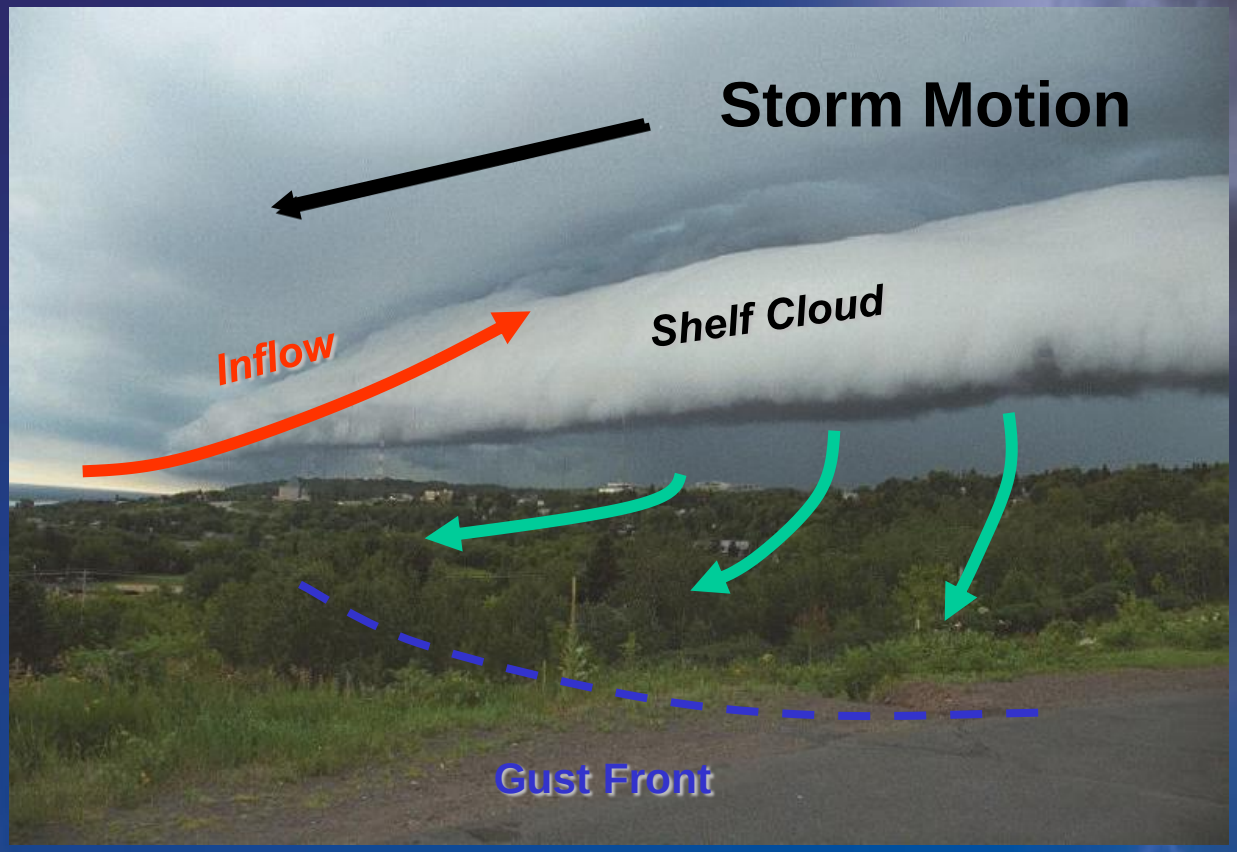
<u>Gust Front</u> - is leading edge of downdraft/ downburst, you don't see it but you do feel it as winds pick up and temperatures drop and then rain/hail.

Squall Line – many tstm cells orientated in a line



(Cross section)

Squall Line Shelf Cloud



Shelf Cloud “marker” is at leading edge (front side).

Main hazards after shelf cloud passes overhead are strong downburst winds, large hail and heavy rains. Tornadoes uncommon.

Downdraft – Microburst!

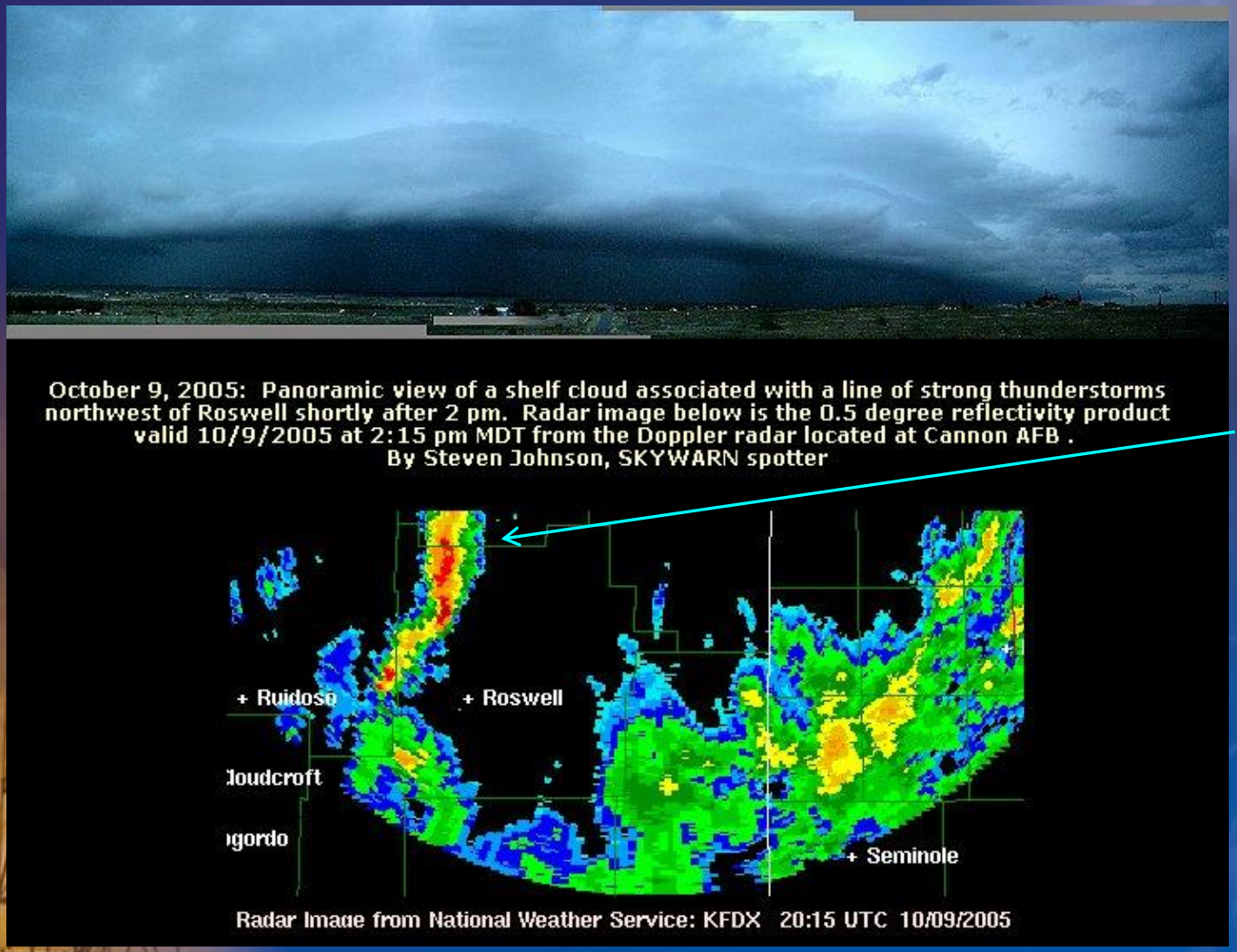
Video

Downburst Winds!

Video – western Ontario, Canada

- **Many times downed trees do NOT indicate tornado damage!**

Shelf Cloud



This Shelf Cloud was found just ahead of squall line in radar image

Shelf Clouds – have SLCs

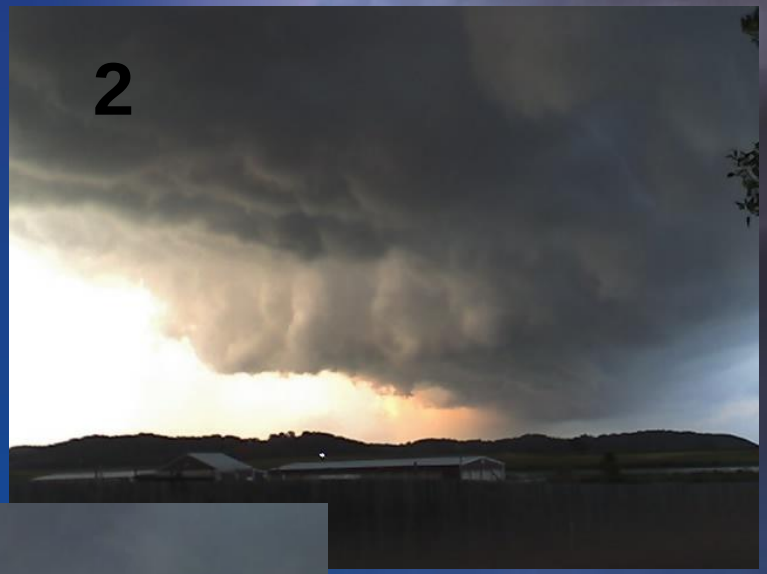
These are often reported as false Funnel Clouds!
…even by trained severe weather spotters! - they don't rotate!

Shelf Cloud - Outflow

Shelf Clouds

"snow-plow' effect

Shelf Cloud & Downdraft



Ryan Sax
Near Lodi
07/28/08

Shelf Cloud

July, 7, 2008, Waupun, Doug Raflik

Shelf Cloud

Pancake layers

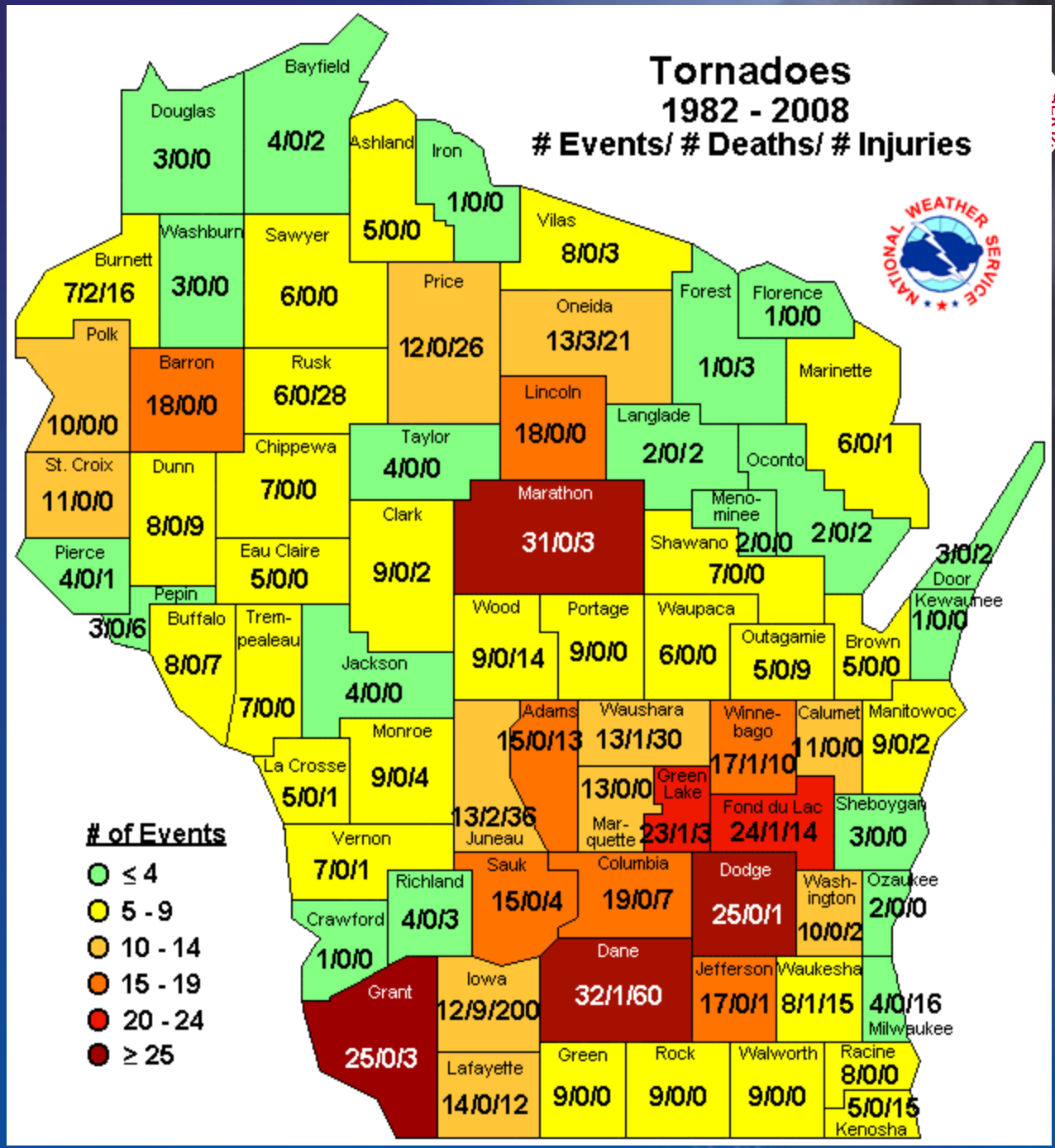
Shelf Clouds – Vernon Co.

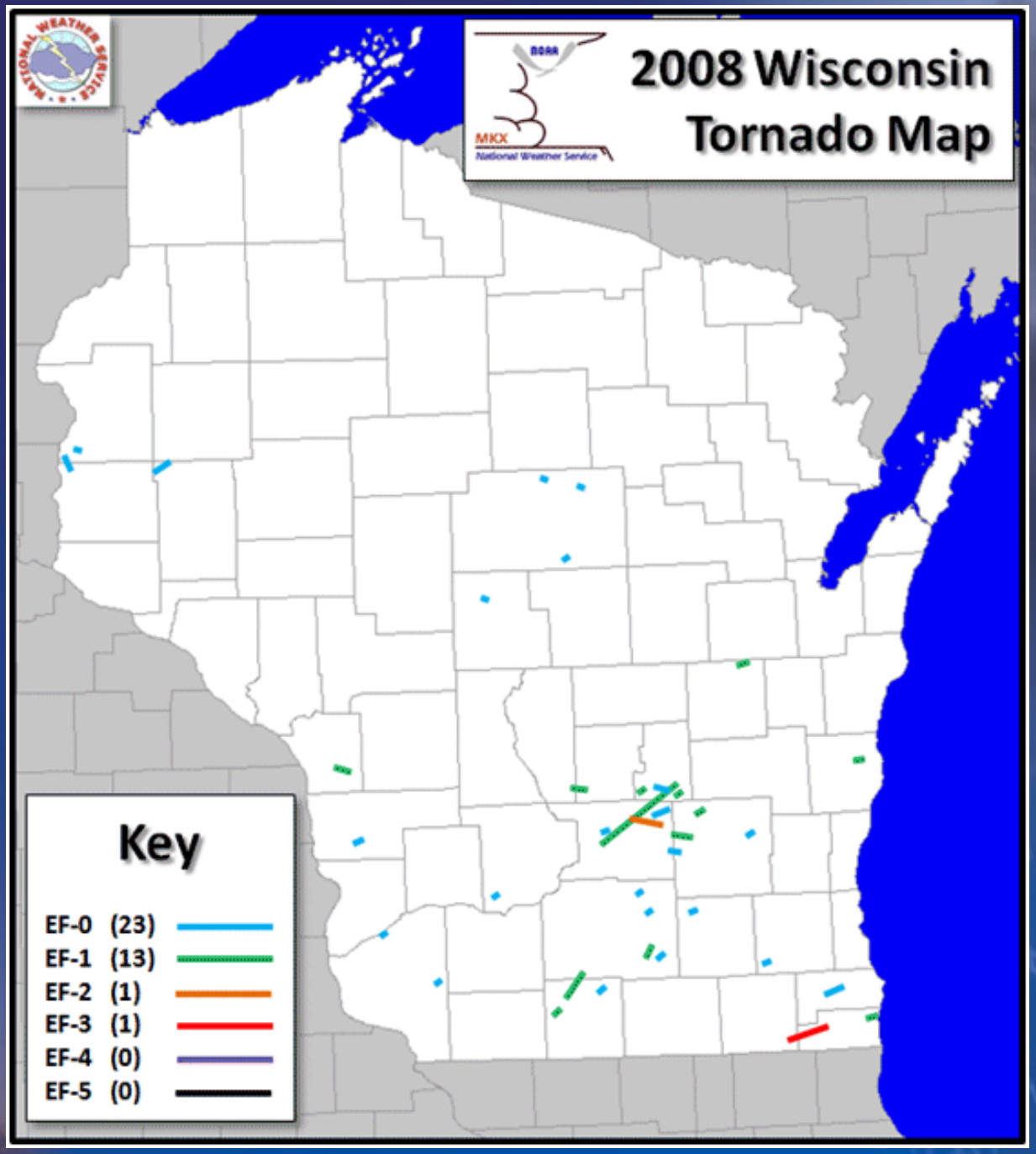
Scary-looking clouds (scud) with shelf cloud

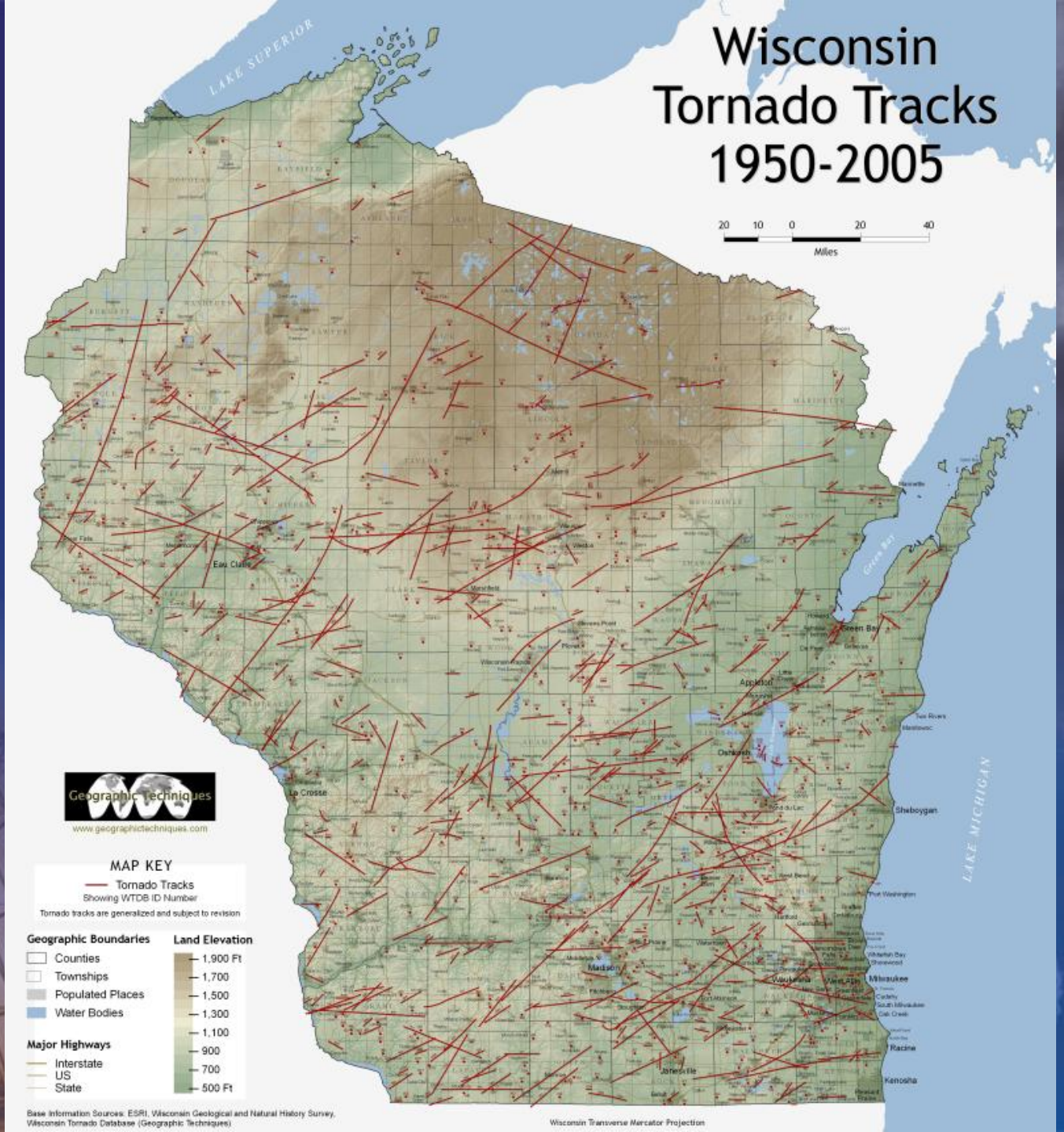
The Tornado

A Rare and Dangerous Storm

- Large or populated counties typically have the higher tornado totals…
- Combine Marquette and Green Lake county and you get 36 tornadoes!




2008 Wisconsin
Tornado Map
MKX
National Weather Service
Key
EF-0 (23)
EF-1 (13)
EF-2 (1)
EF-3 (1)
EF-4 (0)
EF-5 (0)


Wisconsin
Tornado Tracks
1950-2005
20 10 0 20 40
Miles
LAKE SUPERIOR
LAKE MICHIGAN
Eau Claire
Green Bay
Appleton
Oshkosh
La Crosse
Sheboygan
Madison
Milwaukee
Racine
Kenosha
Janesville
Geographic Techniques
www.geographictechniques.com
MAP KEY
Tornado Tracks
Showing WTDB ID Number
Tornado tracks are generalized and subject to revision
Geographic Boundaries
Counties
Townships
Populated Places
Water Bodies
Major Highways
Interstate
US
State
Land Elevation
1,900 Ft
1,700
1,500
1,300
1,100
900
700
500 Ft
Base Information Sources: ESRI, Wisconsin Geological and Natural History Survey, Wisconsin Tornado Database (Geographic Techniques)
Wisconsin Transverse Mercator Projection

Wisconsin Tornadoes

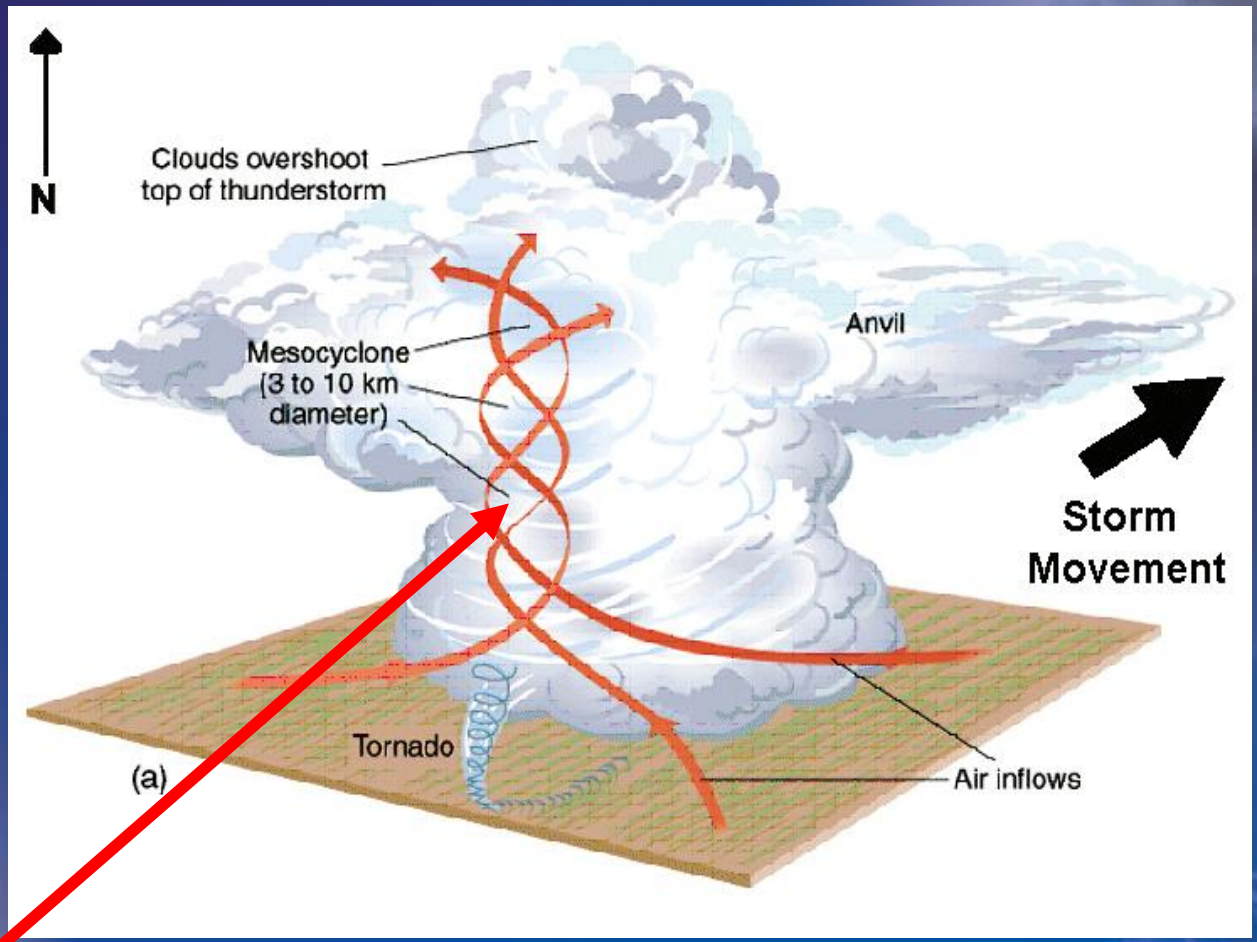
April 21, 1974 near Oshkosh

April 27, 1984 near Wales (Waukesha Co.)

July 18, 1996 approaching Oakfield (Fond du Lac Co.)

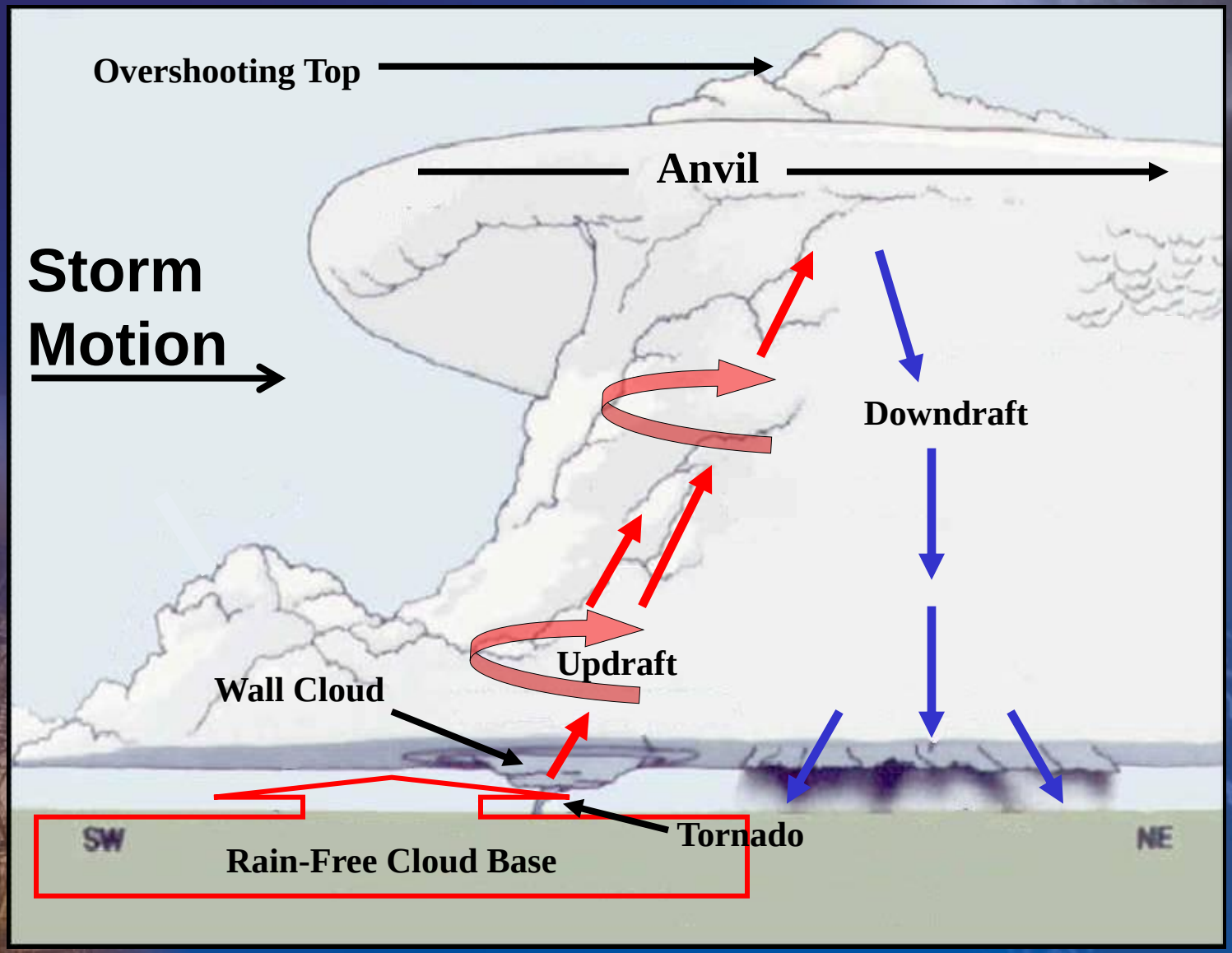
August 18, 2005 in Stoughton (Dane Co.)

Tornadic Thunderstorm



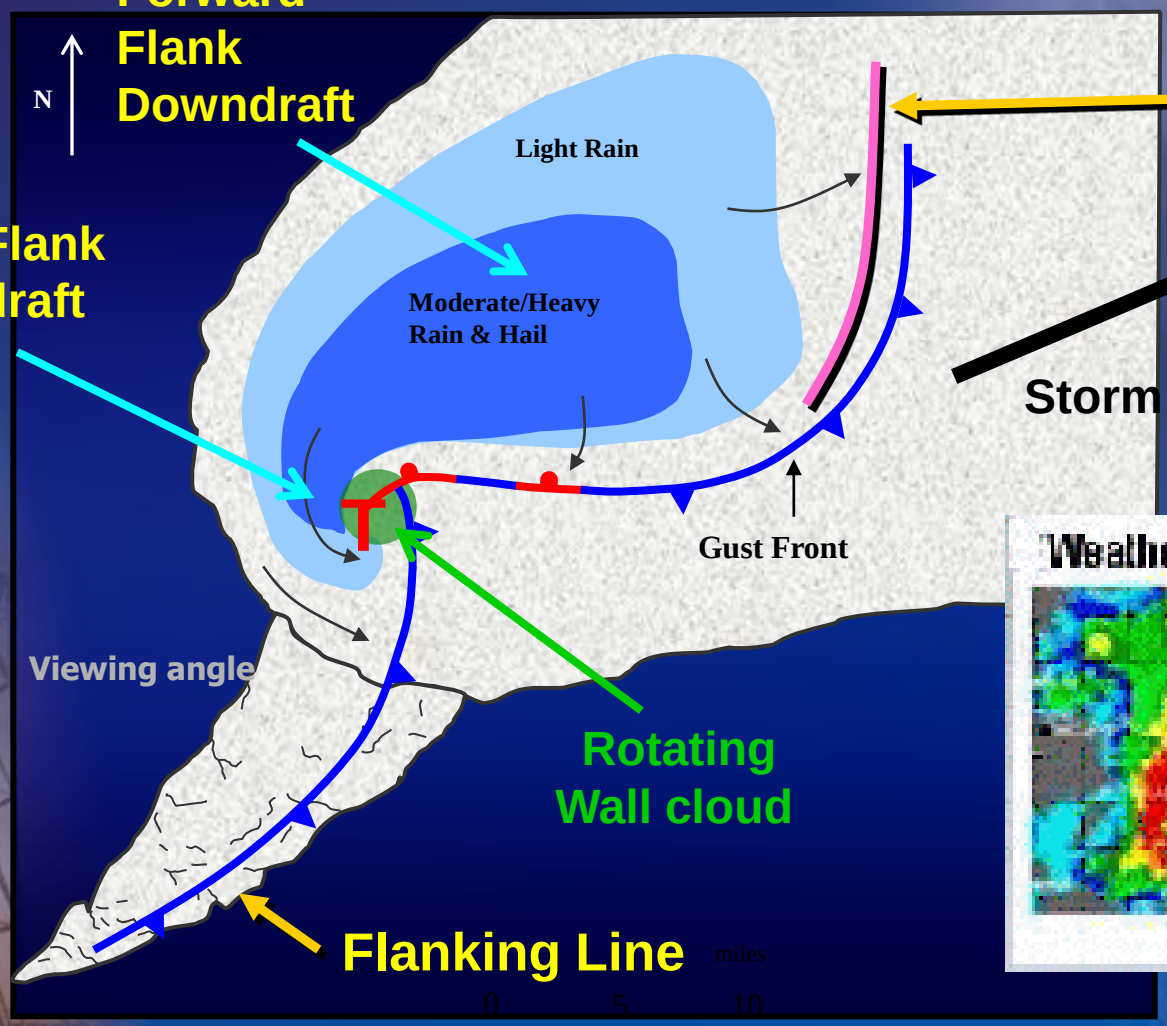
What Doppler Can Detect - Mesocyclone

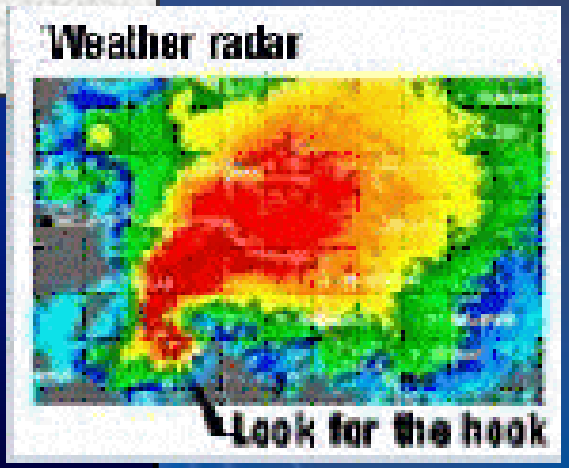
Tornadic Tstm Structure

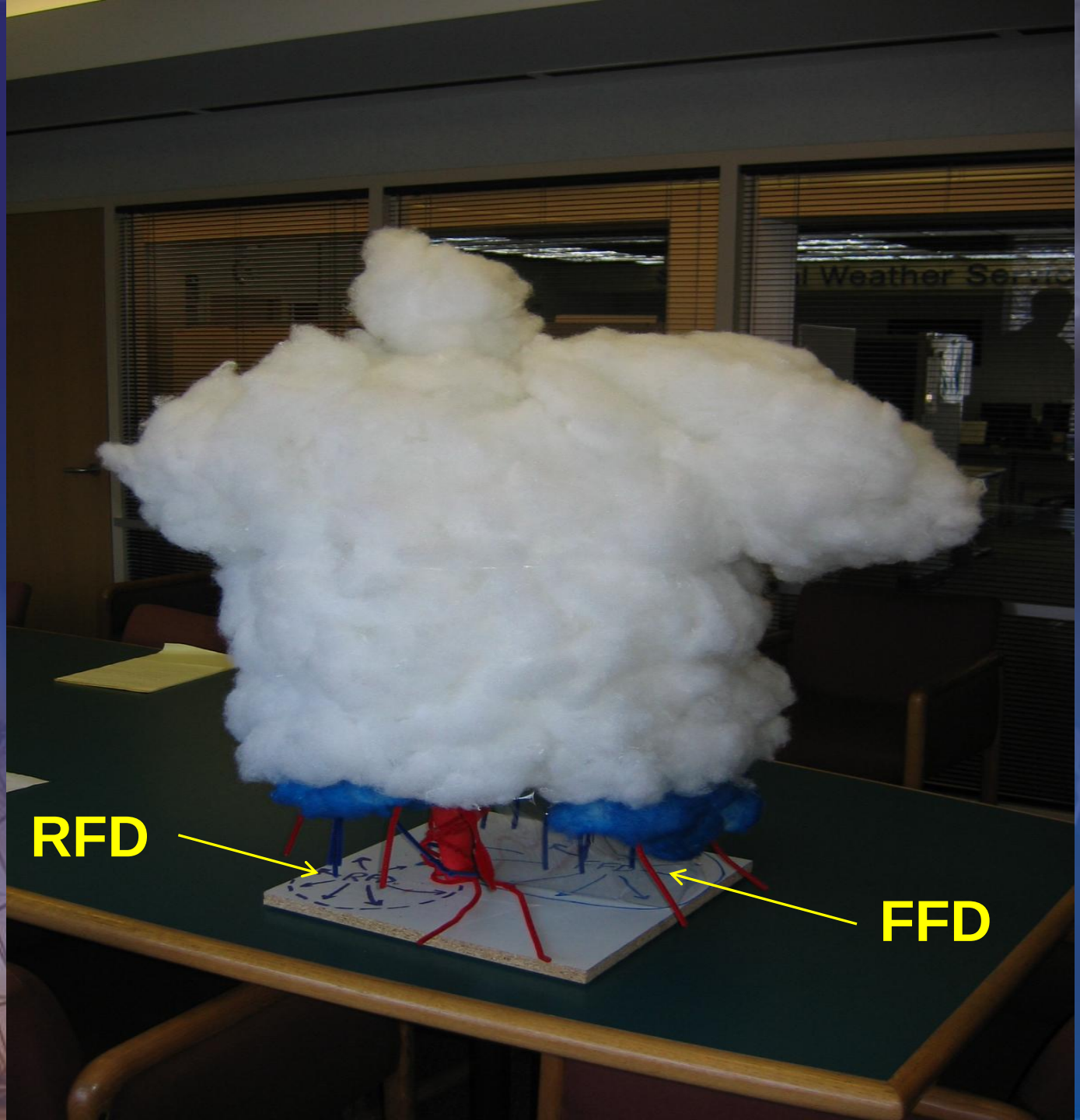


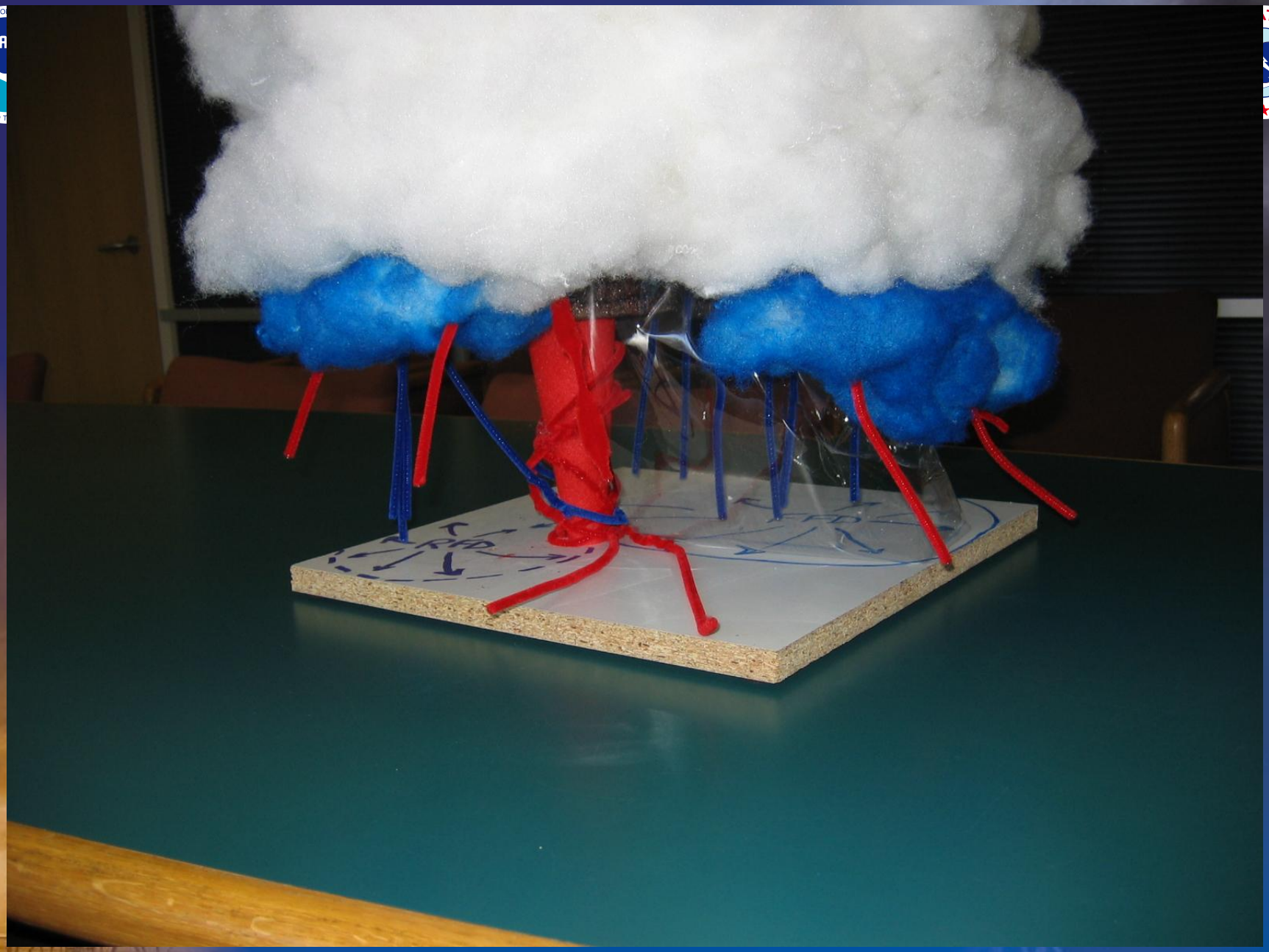
Tornadic Supercell Thunderstorm

top down view

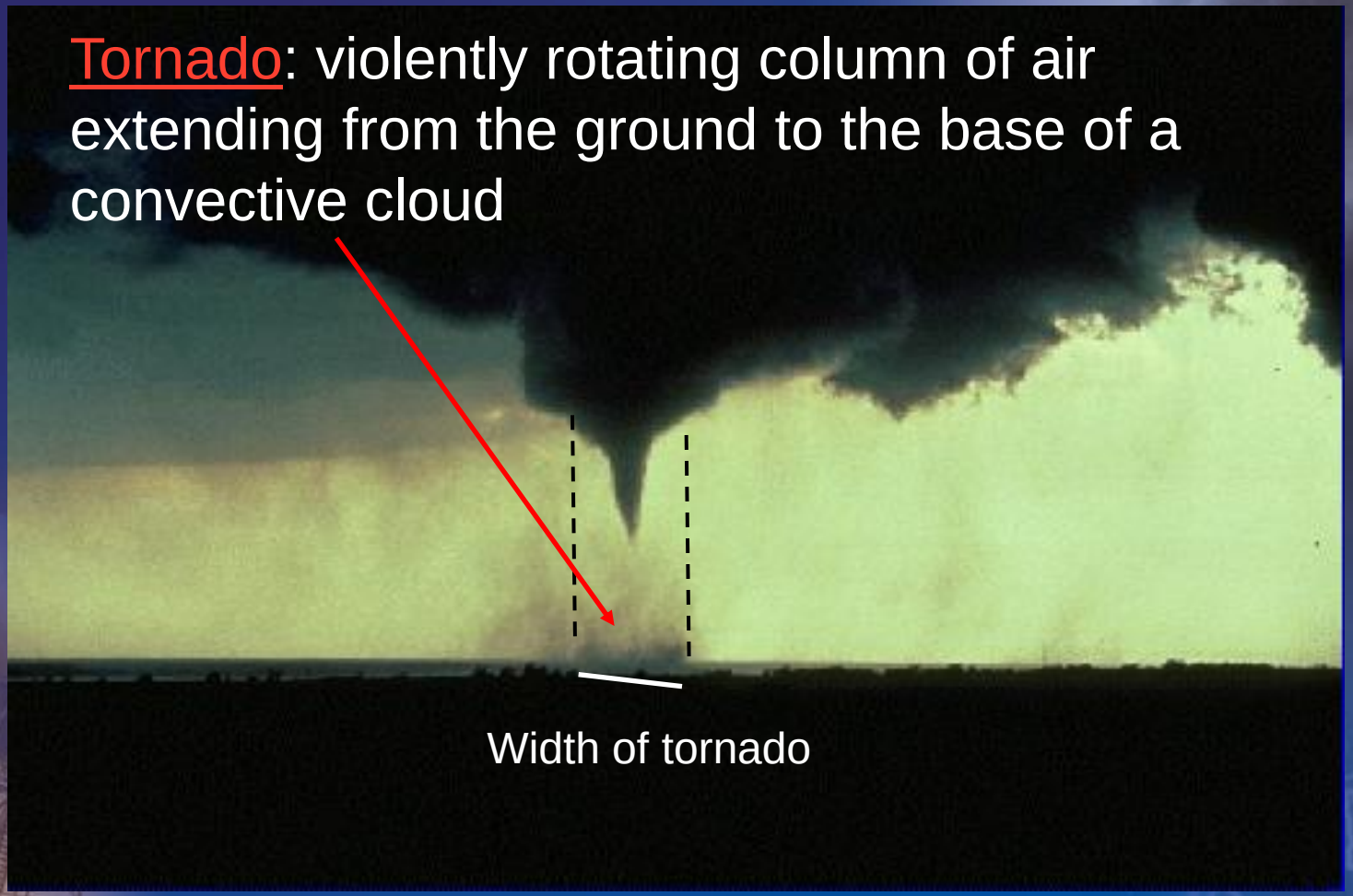





RFD
FFD



Tornado



Note swirling debris at ground level. Condensation funnel doesn't have to "touch" ground…condensation funnel isn't the tornado.

Rotating Wall Clouds

An isolated lowering of the rain-free base, rotating on a vertical axis

Most tornadoes develop underneath or near a rotating wall cloud

Rotating Wall Clouds

- Often exhibit slow, persistent rotation. Rotation that leads to tornado formation takes 10-30 minutes. Patience is the key!
- Strong, upward vertical motion is often found in the vicinity of the rotating wall cloud and its beaver tail. This is where the updraft is the strongest – vacuum sweeper effect. Rising motion - scud is being lifted into the base.
- BUT, rotating wall clouds do NOT always lead to tornado development…..and tornadoes do NOT always develop in association with rotating wall clouds

Rotating Wall Cloud

Video

Rotating Wall Clouds

Wall Cloud Evolution

…5 minutes later

Raflik – Iowa (state)

Rotating Wall Cloud

Rotating Wall Cloud

Rotating Wall Clouds

Tornado or funnel cloud?

Tornado!

Scary Looking Clouds

These are NOT funnel clouds.

Do not be fooled by non-rotating, low-hanging clouds!!

Rotation at Base of Storm

Note strong rotation in base of updraft – rounded/curved appearance with cork-screw characteristics

Rotation in Updraft Tower

Spiral bands and cork-screw look

Tornado Development

Strong inflow from right – wall cloud and beaver tail not evident

…5 minutes later

Funnels – then Tornado

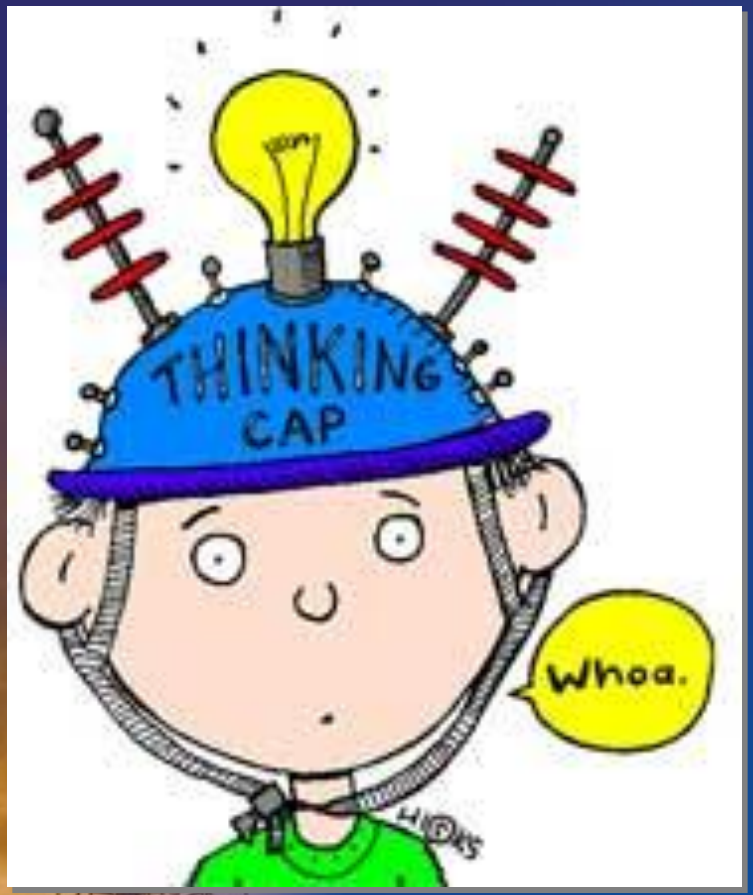
3 funnels?

Note swirling debris – tornado!

(Same storm, but tornado later)

Weak Tornado – see it?

Quiz Time



Shelf clouds and SLCs

Shelf clouds and SLCs

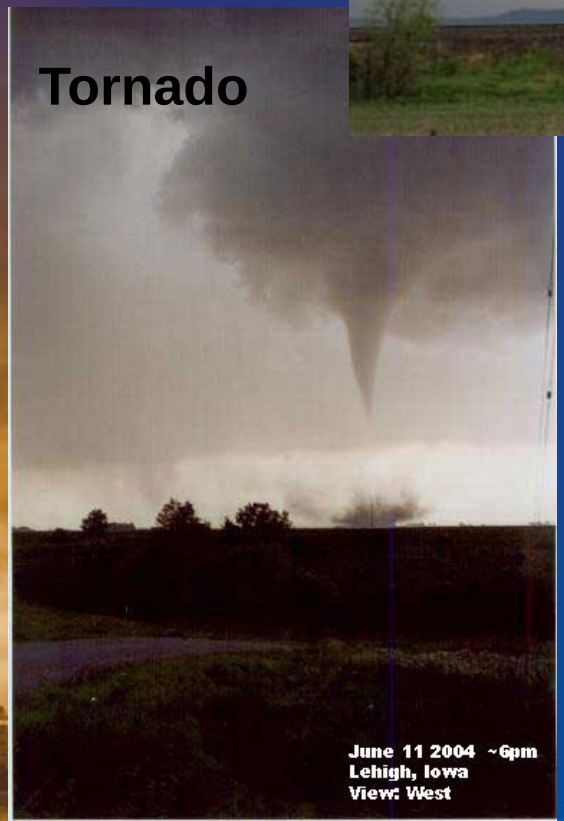
Shelf clouds and SLCs

Shelf clouds and SLCs

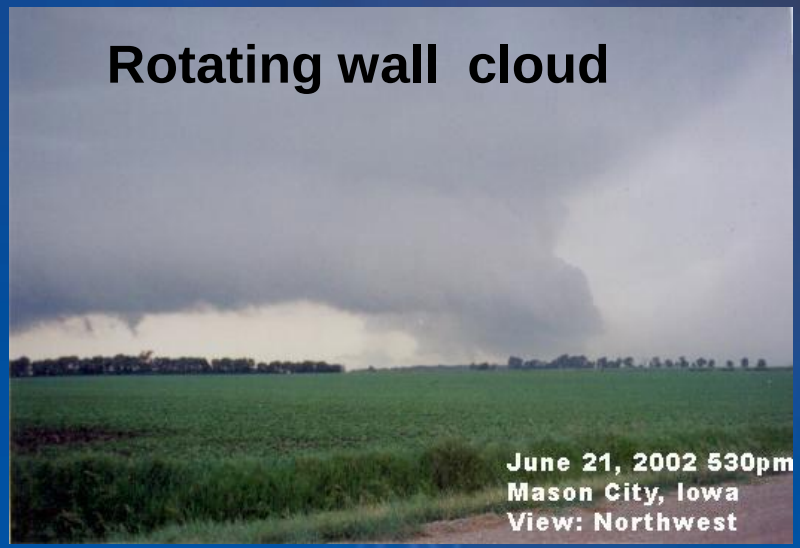
This SLC generated several tornado reports!
It wasn't rotating & there was no damage!

A True Funnel Cloud

Tornadic Weather



Penny Zabel



Funnel Clouds

- Funnel Clouds, by strict definition, do **NOT** come in contact with the ground, nor do they create a rotating dust/debris cloud at ground-level
- A true *funnel cloud* will ALWAYS be rotating

Doug Raflik

Turbulent Cloud Features

SLCs

KSNTV

What Do We Have?

June 11, 2008
Orchard, IA

Rotating Wall Cloud

May 29, 2008
Kearney, NE

Rotating Wall Cloud

What Do We Have?

Rotating Wall Cloud, Look for rotating debris/dirt at ground level for confirmation

Funnel cloud if rotating, otherwise a SLC

What Do We Have?

Janet Kuueger
Sheb Co.

SLC

SLC

Tom Fleming - Dane Co.

NWS Requirement

- Every tornado needs to be properly documented - damage survey for most
- Establish the beginning and ending locations and times, and estimate the strength/intensity of tornado (EF0 to EF5, with EF5 being the strongest)
- Done in conjunction with Emergency Management Director of given county

Dodger…the EF-Scale Dog

EF0

Dodger looking at a weak EF0 Tornado

EF2

Dodger fighting winds from an EF2 Tornado

EF4

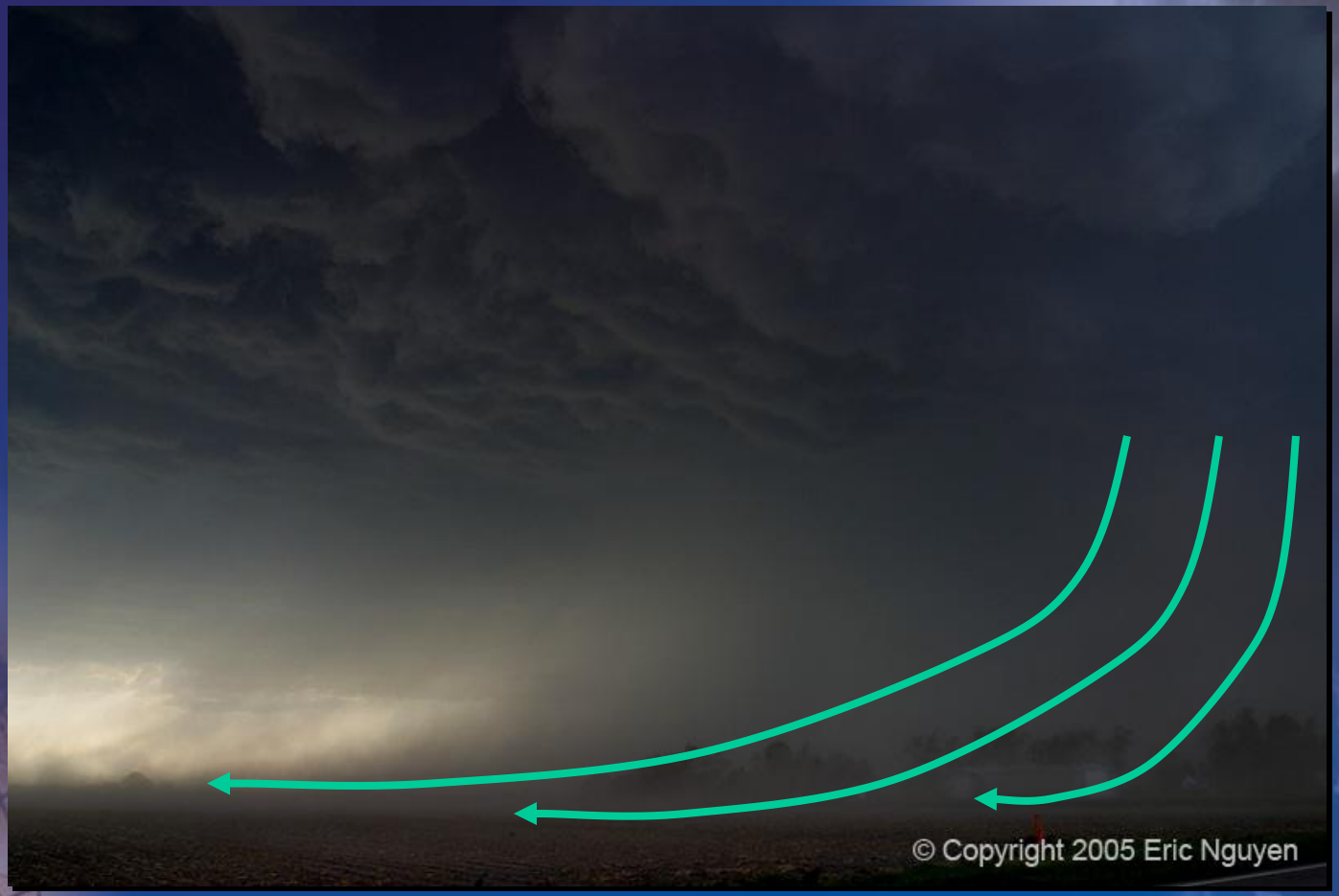
Dodger experiencing EF4 winds

EF5

Dodger was never the same after the EF5

End of Basic Class!!!

Outflow



Definitions

What is a “Severe” Thunderstorm?

(Official NWS Definition)

- Hail diameter = 1 inch or larger
- Wind gusts = 58 mph or greater
- Hail/Wind damage (Svr Tstm Warning 1st three)
- Tornado (Tornado Warning)
- Flash Flood (Flash Flood Warning)

Definitions

- **Tornado**… A violently rotating column of air pendant from a thunderstorm and in contact with the ground
- **Funnel Cloud**… A rotating, funnel-shaped cloud extending from a thunderstorm base not in contact with the ground
- **Downburst** … A strong downdraft with an outflow of damaging wind on or near the ground
- **Flash Flood**… A flood with an onset less than 6 hours after the heavy rainfall or causative event (such as a dam break).

Wisconsin Tornado Stats

- Most tornadoes spin up between 3 pm and 9 pm, with 6-7 pm being the busiest.
- Most tornadoes occur between April and September, with June being the peak month.
- Tornadoes generally move southwest to northeast, but west to east, and northwest to southeast movements are quite possible.

Safety Tips & Myths

Tornado Safety Tips

- Go into a sturdy building
- Go to the lowest level and try to get under a heavy desk, table, or bench
- Put as many walls between you and the outside of the building – an interior bathroom or hallway
- Stay away from windows
- Get out of your vehicle
- Do not go under the highway overpass – lie flat on ground

Safety Tips & Myths

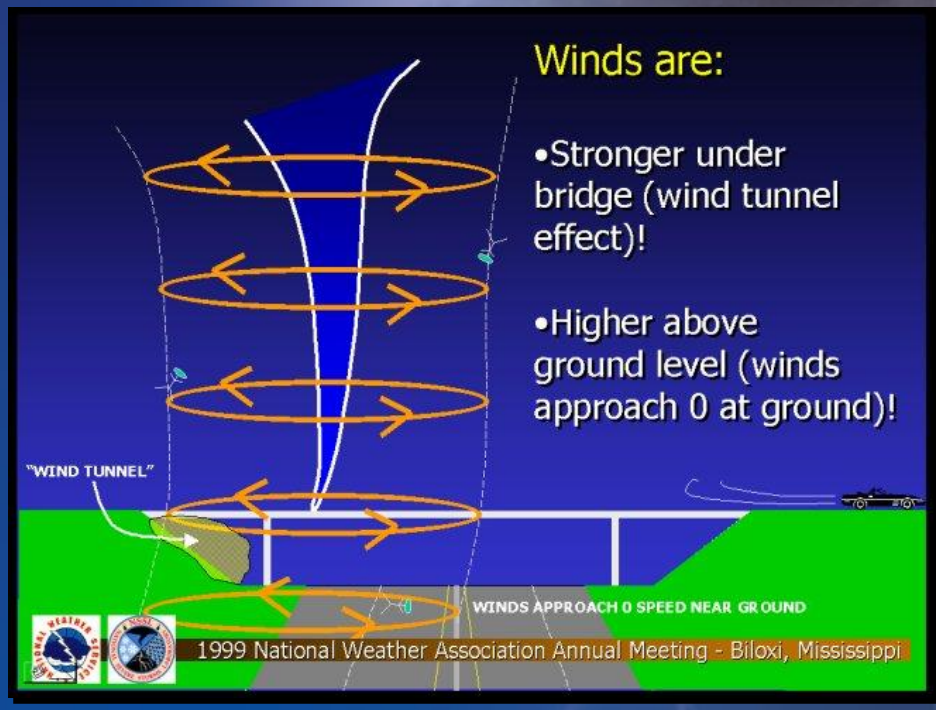
Tornado Myths

- You need a funnel cloud in order to have a tornado.
- Structural damage results only from tornadoes, not tstm winds
- Tornadoes do not travel up, over, through, or near mountains, hills, ridges, river valleys, lakes, swamps, bogs, cities & tall buildings.
- Opening the windows & doors will equalize the air pressure so that the building doesn't explode.
- The southwest side of the basement is the safest place to be.
- New homes can withstand a tornado (they are well-built).

Tornado Safety

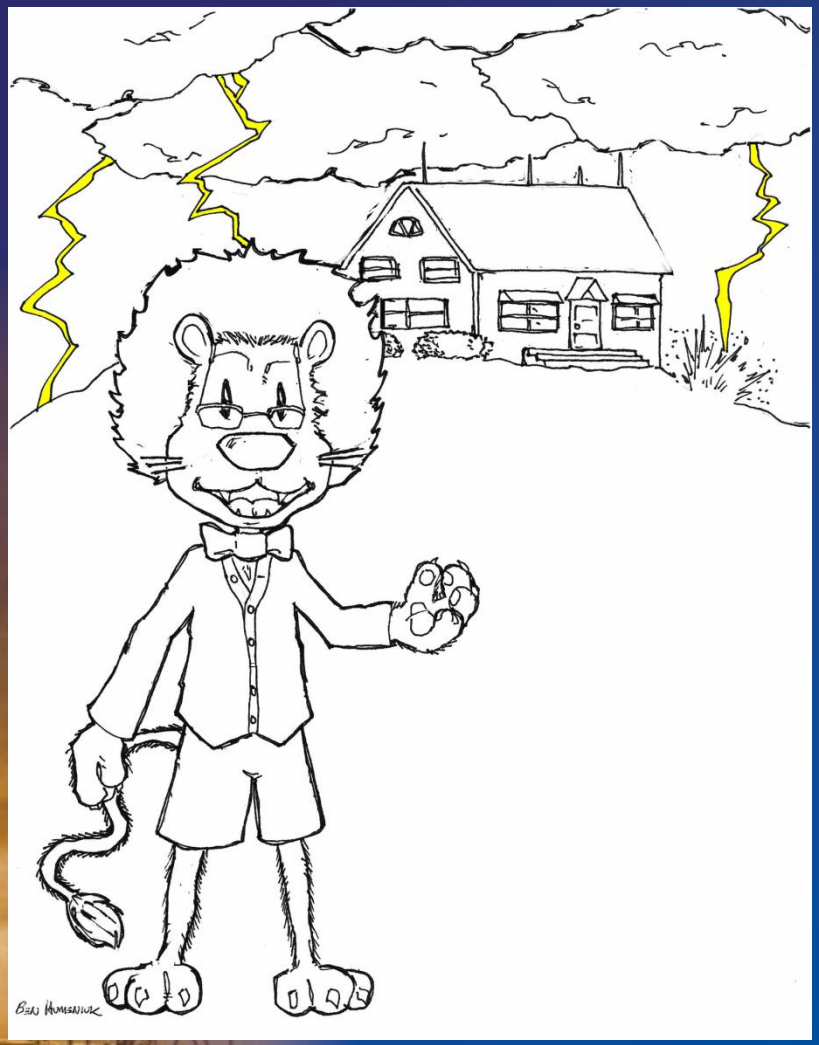
Tornadoes often occur very rapidly. Have a pre-designated shelter in mind before a storm strikes.

- **Go to the lowest level of a building or your home and stay away from windows**
- **Put as many walls between you and the storm as possible**
- **Get out of automobiles and mobile homes and move to safe shelter**



Underpasses should NOT be used as a place of shelter during a tornado !!

Lightning Safety



Leon the Lightning Lion says:

Lightning can hurt you, even before it rains!

When you hear thunder:

– Go indoors quickly

– Head for a house, school or large fully enclosed building

– If you can't get indoors, get in a hard top car, bus or truck

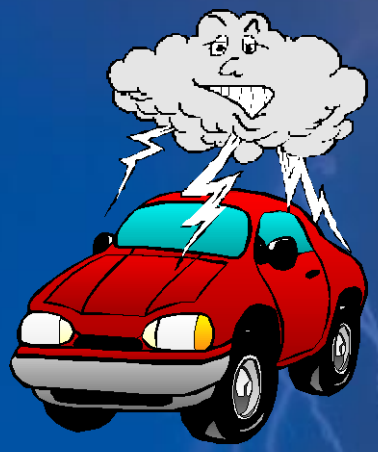
Lightning

- Another common thunderstorm killer.
- Can strike many miles away from storm.
- If you can hear thunder, you can be struck.

Video

Lightning Safety

• Outdoors: Avoid elevated places and open spaces. Stay away from water and tall isolated objects. Do not go under trees. Allow time to reach safety. Don't seek refuge in open structures.



Lightning Safety

- 30 - 30 Rule: If 30 sec or less between lightning and its thunder, go inside. Stay inside 30 minutes or more after the last rumble.
- Inside – Don’t use corded phones, electrical appliances, wiring, plumbing, and stay away from windows

Lightning Safety

Remember, if you can hear thunder, you are close enough to be struck by lightning!

- If lightning is occurring, move to a sturdy building or vehicle
- If caught outdoors, find a low spot away from tall objects
- If you feel your skin tingle or hair stand up, squat low to the ground on the balls of your feet

Lightning Safety

Photo by Chris Novy

- Stay away from trees and power poles
- Unplug electronics
- Cordless phones, cell phones, and handheld radios are okay to use – as long as you are in a safe shelter

Lightning Safety

A Two Step Process…

1. If you hear thunder, go indoors or get into a vehicle immediately !
2. Stay indoors for 30 minutes after hearing the last clap of thunder.

Flash Flood Safety

- **Be especially cautious at night!**

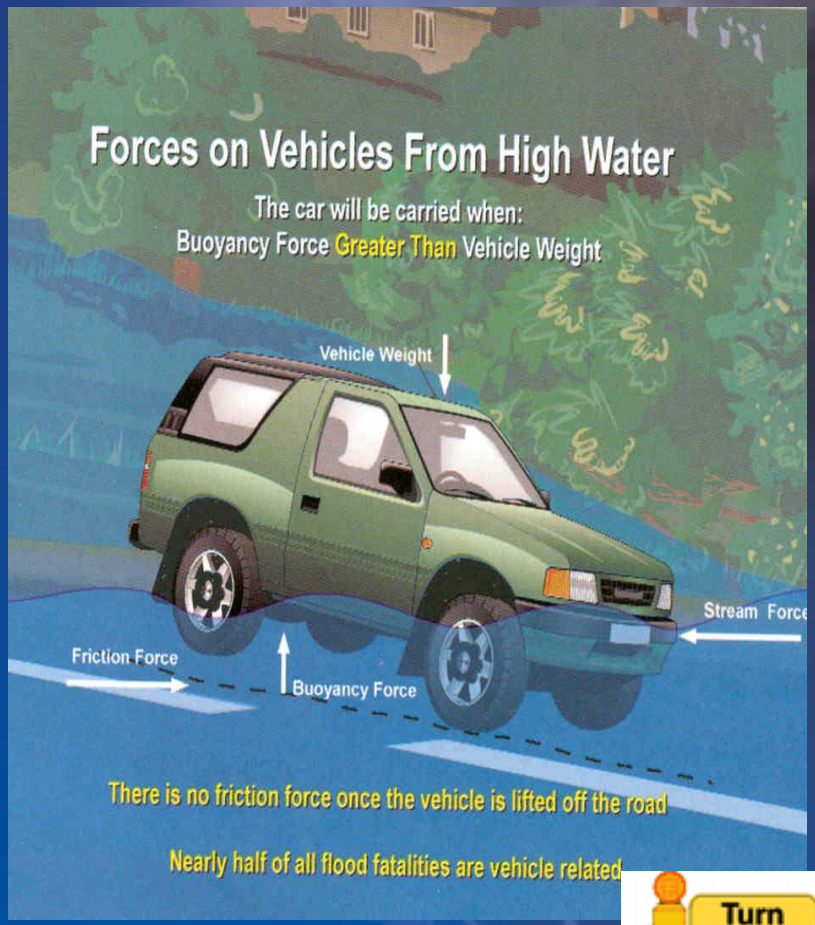
- **2 feet of water can float away most cars.**

video

Amazing how powerful we feel…when we get behind the wheel….

Flood Safety in a Vehicle

- **NEVER drive into water** covering the road. You do not know how deep it is or if the road is washed out.
- **Turn around and go the other way!** Look out for flooding at **highway dips, bridges, and low areas.**
- If the vehicle stalls, ***leave it immediately and seek higher ground.***
- **Be especially cautious at night** when it's harder to recognize flood dangers.



Hail Safety

Large hail is seldom a threat to life but there have been reports of injuries

- If caught outdoors, move indoors away from windows
- If in your car, slow down and look for a place to pull off…but not under a bridge or underpass!
- Stay indoors, or in your vehicle !!

Damage from wind driven hail

Tstm Wind Safety

- Stay away from windows and move into an interior room.
- If you have a basement, go ahead and move downstairs if a Severe Thunderstorm warning is issued.
- Stay clear of trees and power lines.

- If you live in a mobile home, take the same precaution when a severe thunderstorm warning is issued as you would if a tornado warning was issued.

Enhanced Fujita Scale

Wind estimates based on damage assessment (intensity)

Original F scale	Wind Speed	Enhanced F scale	Rating 3 second gust
F0	40-72 mph	EF0	65-85 mph
F1	73-112 mph	EF1	86-110 mph
F2	113-157 mph	EF2	110-135 mph
F3	158-207 mph	EF3	136-165 mph
F4	208-260 mph	EF4	166-200 mph
F5	261-318 mph	EF5	>200 mph

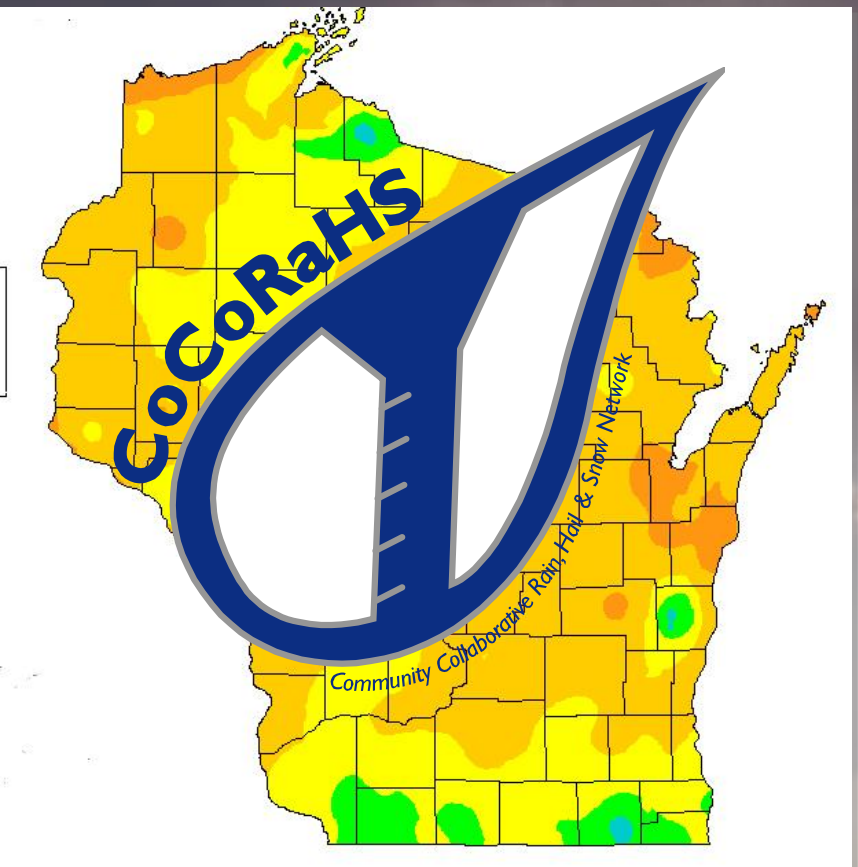
Wind speeds in mph, 3-second gust

http://www.spc.noaa.gov/efscale/

Squall Line

- How can you tell if you are looking at a Squall Line? *Look for the Shelf Cloud.*
- Squall line winds can reach speeds equal to that of an EF1 or EF2 tornado.
- Another main threat is Flash Flooding!

Would you like to be part of CoCoRaHS? It's a web-based, COMMUNITY COLLABORATIVE RAIN, HAIL AND SNOW NETWORK (CoCoRaHS) in Wisconsin



CoCoRaHS is a grassroots, non-profit, high-density network of dedicated, responsible volunteers who share DAILY precipitation measurements with other people and scientists via the internet (including the NWS).

If interested, please go to this web site…

www.cocorahs.org